


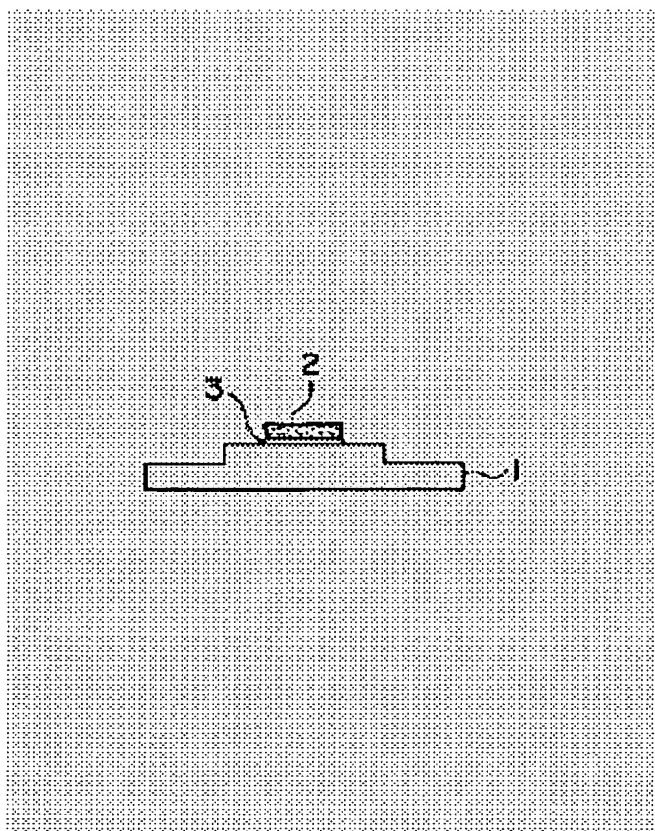
**HIGH HEAT RADIATION METAL COMPOSITE SHEET AND HIGH HEAT RADIATION METAL SUBSTRATE USING THE SAME**

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**PROBLEM TO BE SOLVED:** To obtain a high heat radiation metal substrate by using a high heat radiation metal composite sheet having low coefficient of thermal expansion and high heat radiation characteristics, reduced in weight, and excellent in workability.

**SOLUTION:** A high heat radiation metal composite sheet, which is prepared by subjecting a powder mixture, consisting of, by weight, <40% copper (Cu), 0.5-5% silicon carbide (SiC), and the balance molybdenum (Mo), to compacting and to sintering and then rolling the resultant sintered compact and further has characteristics of  $6.0-8.5[\times 10^{-6} / \text{deg.C}]$  average thermal expansion coefficient,  $\leq 10\text{g/cm}^3$  density, and  $\geq 200\text{W/m.K}$  thermal conductivity, is used as a substrate material. Projection stepping is applied to this sheet to form a protrudedly stepped substrate 1. Then, a silicon chip 2 is provided onto the protrudedly stepped substrate 1 by means of a solder 3, by which the high heat radiation metal substrate can be obtained.



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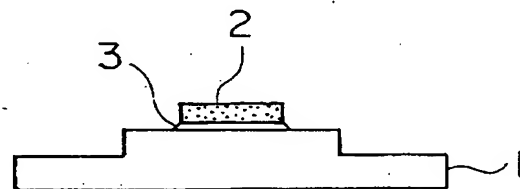
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(54) 【発明の名称】 高放熱性金属複合板材及びそれを用いた高放熱性金属基板

(57) 【要約】

【課題】 低熱膨張率で放熱性が高く、しかも軽量で加工性の優れた高放熱性金属複合板材を用いた高放熱性金属基板を提供すること。

【解決手段】 この高放熱性金属基板は、40wt%未満の銅 (Cu) 及び0.5~5 [wt%] の炭化珪素 (SiC) と残部モリブデン (Mo) とを混合して成る混合粉末を成形、焼結した後、圧延することで作製されると共に、平均熱膨張係数が6.0~8.5 [ $\times 10^{-6}$  / $^{\circ}$ C] の範囲にあつて、密度が10g/cm<sup>3</sup> 以下、熱伝導率が200W/m・K以上の特性を有する基板材料としての高放熱性金属複合板材に凸型段付けを施して凸型段付き基板1を成した後、凸型段付き基板1上に半田3によりシリコンチップ2を設けて構成される。



## 【特許請求の範囲】

【請求項1】 40wt%未満の銅(Cu)及び0.5～5[w t%]の炭化珪素(SiC)と残部モリブデン(Mo)とを混合して成る混合粉末を成形、焼結した後、圧延することで作製されると共に、平均熱膨張係数が $6.0 \sim 8.5 [ \times 10^{-6} / ^\circ \text{C} ]$ の範囲にあることを特徴とする高放熱性金属複合板材。

【請求項2】 請求項1記載の高放熱性金属複合板材において、密度が $10 \text{ g/cm}^3$ 以下であると共に、熱伝導率が $200 \text{ W/m} \cdot \text{K}$ 以上の特性を有することを特徴とする高放熱性金属複合板材。

【請求項3】 請求項1又は2記載の高放熱性金属複合板材に段付けを施して得た基板上にシリコン半導体素子を設けて成ることを特徴とする高放熱性金属基板。

## 【発明の詳細な説明】

## 【0001】

【発明の属する技術分野】本発明は、セラミックパッケージ等への組み込みが好適な高放熱性金属複合板材及びそれを用いた高放熱性金属基板に関する。

## 【0002】

【従来の技術】従来、半導体素子の支持用電極や搭載用基板は、チップの高密度化、データ伝送の高速化等に伴って使用時の発熱量が増大している。このような発熱量の増大化は、半導体素子の誤動作や劣化、破損等を招く原因となっている。

【0003】このため、基板材料には基本的な特性として、放熱効果が高く、しかも半導体素子自体やその周辺材料に対して熱膨張係数が近似したできるだけ軽量なものをを用いることが望まれている。又、基板材料には半導\*

表 1 TT-RCMの特性

銅 質 量 %	O (Mo)	20	40	60	80	100(Cu)
密 度 ( $\text{g/cm}^3$ )	10.2	9.9	9.6	9.4	9.2	8.9
熱膨張係数 ( $\times 10^{-6} / ^\circ \text{C}$ )	5.1	7.5	8.7	12.3	15.9	17.0
熱 伝 導 率 ( $\text{W/m} \cdot \text{K}$ )	142	170	234	286	338	394

【0008】この表1からは、例えば銅(Cu)の含有量が40wt%以上のものに関しては、熱伝導率が高いものの、熱膨張係数がやや大きくなっていることが判る。このため、このようなCu-Mo混合比のものをセラミックパッケージ組み込み用の基板材料として用いると、セラミックパッケージとのミスマッチングのために亀裂等が発生してしまう危険がある。

【0009】これに対し、銅(Cu)の含有量が40wt%未満のものについては、熱膨張係数が小さいことにより、セラミックパッケージ組み込み用の基板材料として用いればセラミックパッケージとのマッチング性が良好となるという利点があるが、この反面、熱伝導率が小さいことにより、チップで発生する熱を逃がし難く誤動作等を招く危険性があり、信頼性が損われてしまう。

\* 体素子自体以外にもこれを搭載した状態の基板を組み込むためのパッケージの材料に対して熱膨張係数が近似しているものを用いることが所望されたり、或いは組立後のマッチングを考慮して半導体素子自体やその周辺材料に対して若干熱膨張係数が異なるものを用いることが所望される場合もある。更に、基板材料には基板をパッケージへ組み込むための準備工程として、臘付けやメッキを施し易いこと等も要求されている。加えて、基板には平板のみならず、凹型や凸型等の段付きタイプのものであるため、基板材料にはこのような段付け加工が容易であることも要求されている。

【0004】このような要求を満たし得る高放熱性の基板材料(板材)として、近年ではCu-Mo系複合材料(TT-RCM)が開発され、既に実用化されている。

## 【0005】

【発明が解決しようとする課題】上述したCu-Mo系複合材料(TT-RCM)の場合、最近の半導体素子用基板材料に対する要求、即ち、低熱膨張率で放熱性が高く、しかも軽量であるという要求を十分に満たし得ないという問題がある。

【0006】具体的に云えば、下記の表1に示されるように、粉末混合法で作製した幾つかの異なるCu-Mo混合比のCu-Mo系複合材料(TT-RCM)特性において、熱膨張率が低ければ放熱性が劣る等、何れのものに関しても上述した最近の基板材料への要求を満たし得ないことが判る。

## 【0007】

## 【表1】

【0010】即ち、従来のCu-Mo系複合材料(TT-RCM)の場合、最近の半導体素子用基板材料に対する要求を満たし得ず、セラミックパッケージへの組み込み用の基板材料として用いる場合にも機械加工性が悪く、適用し難いという問題がある。

【0011】ところで、Cu-Mo系複合材料(TT-RCM)以外の基板材料、即ち、熱膨張係数が $8.5 \times 10^{-6} / ^\circ \text{C}$ 以下で熱伝導率が $200 \text{ W/m} \cdot \text{K}$ 以上の基板材料として、銅-タングステン(CMSH)が知られているが、この銅-タングステン(CMSH)は密度が $15.6 \sim 17 [\text{g/cm}^3]$ と大きく、軽量化の具現に難がある上、機械加工性が悪いこと等により、上述したCu-Mo系複合材料(TT-RCM)の場合と同様に、最近の半導体素子用基板材料としては実用に適さない。

【0012】本発明は、このような問題点を解決すべくなされたもので、その技術的課題は、低熱膨張率で放熱性が高く、しかも軽量で機械加工性の優れた高放熱性金属複合板材及びそれを用いた高放熱性金属基板を提供することにある。

#### 【0013】

【課題を解決するための手段】本発明によれば、40wt%未満の銅(Cu)及び0.5~5[w t%]の炭化珪素(SiC)と残部モリブデン(Mo)とを混合して成る混合粉末を成形、焼結した後、圧延することで作製されと共に、平均熱膨張係数が $6.0 \sim 8.5 [ \times 10^{-6} / ^\circ \text{C} ]$ の範囲にある高放熱性金属複合板材が得られる。

【0014】又、本発明によれば、上記高放熱性金属複合板材において、密度が $10 \text{ g/cm}^3$ 以下であると共に、熱伝導率が $200 \text{ W/m} \cdot \text{K}$ 以上の特性を有する高放熱性金属複合板材が得られる。

【0015】更に、本発明によれば、上記何れかの高放熱性金属複合板材に段付けを施して得た基板の上にシリコン半導体素子を設けて成る高放熱性金属基板が得られる。

#### 【0016】

【発明の実施の形態】以下に実施例を挙げ、本発明の高放熱性金属複合板材及びそれを用いた高放熱性金属基板について、図面を参照して詳細に説明する。

【0017】最初に、本発明の高放熱性金属複合板材の概要を簡単に説明する。この高放熱性金属複合板材は、40wt%未満の銅(Cu)及び0.5~5[w t%]の炭化珪素(SiC)と残部モリブデン(Mo)とを混合して成る混合粉末を成形、焼結した後、圧延することで作製される。この高放熱性金属複合板材の諸特性は、平均熱膨張係数が $6.0 \sim 8.5 [ \times 10^{-6} / ^\circ \text{C} ]$ の範囲にあり、密度が $10 \text{ g/cm}^3$ 以下であると共に、熱伝導率が $200 \text{ W/m} \cdot \text{K}$ 以上となっている。

【0018】このような高放熱性金属複合板材に段付け加工により段付けを施して基板を成し、その基板の上にシリコン半導体素子を設ければ、セラミックパッケージへの組み込みが最適な高放熱性金属基板として構成される。

【0019】そこで、以下は幾つかの実施例に基づいて材料組成比(組成含有量)が異なる高放熱性金属複合板材について、その製造方法を合わせて具体的に説明する。

【0020】<実施例1>実施例1では、先ず原料粉末として、モリブデン(Mo)粉末、電解銅(Cu)粉末、及び炭化珪素(SiC)粉末を70:30:3.1の割合で混合し、プレス成形した後、水素雰囲気中で焼結した。次に、この焼結体を水素雰囲気中にて900℃で15分間加熱保持した後、熱間圧延加工してから冷間圧延加工を施すことで厚さ1.0mmの板材に仕上げ

た。

【0021】そこで、この板材の諸特性を調べたところ、熱膨張係数( $\alpha$ )は $7.5 \times 10^{-6} / ^\circ \text{C}$ 、熱伝導率( $\kappa$ )は $220 \text{ W/m} \cdot \text{K}$ 、密度( $\rho$ )は $9.7 \text{ g/cm}^3$ であった。

【0022】又、この板材に電解で膜厚が $3 \mu \text{m}$ となるようにニッケル(Ni)メッキを成膜した後、水素雰囲気中にて $850^\circ \text{C} \times 20$ 分の条件下で熱処理して成膜加工性を調べたところ、メッキに関して膨れ、変色、染み等の変質は無く、不良は認められなかった。

【0023】因みに、比較として炭化珪素(SiC)を含まずにモリブデン(Mo)粉末:電解銅(Cu)粉末を70:30として同様な手順で作製した板材に関して諸特性を調べたところ、熱膨張係数( $\alpha$ )は $7.7 \times 10^{-6} / ^\circ \text{C}$ 、熱伝導率( $\kappa$ )は $190 \text{ W/m} \cdot \text{K}$ 、密度( $\rho$ )は $9.7 \text{ g/cm}^3$ であった。

【0024】<実施例2>実施例2では、原料粉末として、モリブデン(Mo)粉末、電解銅(Cu)粉末、及び炭化珪素(SiC)粉末を70:30:4.2の割合で混合し、この後は実施例1と同様な手順を経て厚さ1.0mmの板材を作製した。

【0025】そこで、この板材の諸特性を調べたところ、熱膨張係数( $\alpha$ )は $7.3 \times 10^{-6} / ^\circ \text{C}$ 、熱伝導率( $\kappa$ )は $230 \text{ W/m} \cdot \text{K}$ 、密度( $\rho$ )は $9.7 \text{ g/cm}^3$ であった。

【0026】又、ここでは実施例1の場合と同様にNiメッキを施し、熱処理した後、更にシリコンウエハーに銀臘(BAg-8)付けを行ったところ、Niメッキ及び銀臘の密着加工性は良好で、亀裂や剥離等の不良が認められなかった。

【0027】因みに、ここでも比較として炭化珪素(SiC)を含まずにモリブデン(Mo)粉末:電解銅(Cu)粉末を70:30として作製した板材に関して同様に臘付けまでの工程を行ったところ、臘付け部に亀裂が認められ、密着加工性が劣化されることが判った。

【0028】<実施例3>実施例3では、原料粉末として、モリブデン(Mo)粉末、電解銅(Cu)粉末、及び炭化珪素(SiC)粉末を80:20:4.2の割合で混合し、実施例1と同様な手順を経て厚さ1mmの板材を作製した。

【0029】そこで、この板材の諸特性を調べたところ、熱膨張係数( $\alpha$ )は $6.7 \times 10^{-6} / ^\circ \text{C}$ 、熱伝導率( $\kappa$ )は $210 \text{ W/m} \cdot \text{K}$ 、密度( $\rho$ )は $9.8 \text{ g/cm}^3$ であった。

【0030】又、ここでも実施例2の場合と同様にNiメッキや銀臘付けを施して密着加工性を調べたところ、良好であった。

【0031】因みに、ここでも比較として炭化珪素(SiC)を含まずにモリブデン(Mo)粉末:電解銅(Cu)粉末を80:20として同様な手順で作製した板材

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に関して諸特性を調べたところ、熱膨張係数 ( $\alpha$ ) は  $6.9 \times 10^{-6}/^{\circ}\text{C}$ 、熱伝導率 ( $\kappa$ ) は  $175 \text{ W/m} \cdot \text{K}$ 、密度 ( $\rho$ ) は  $9.9 \text{ g/cm}^3$  であった。

【0032】<実施例4>実施例4では、原料粉末として、モリブデン (Mo) 粉末、電解銅 (Cu) 粉末、及び炭化珪素 (SiC) 粉末を90:10:5.3の割合で混合し、実施例1と同様な手順を経て厚さ1mmの板材を作製した。

【0033】そこで、この板材の諸特性を調べたところ、熱膨張係数 ( $\alpha$ ) は  $6.0 \times 10^{-6}/^{\circ}\text{C}$ 、熱伝導率 ( $\kappa$ ) は  $202 \text{ W/m} \cdot \text{K}$ 、密度 ( $\rho$ ) は  $10.0 \text{ g/cm}^3$  であった。

【0034】因みに、ここでも比較として炭化珪素 (SiC) を含まずにモリブデン (Mo) 粉末：電解銅 (Cu) 粉末を90:10として同様な手順で作製した板材に関して諸特性を調べたところ、熱膨張係数 ( $\alpha$ ) は  $6.2 \times 10^{-6}/^{\circ}\text{C}$ 、熱伝導率 ( $\kappa$ ) は  $163 \text{ W/m} \cdot \text{K}$ 、密度 ( $\rho$ ) は  $10.0 \text{ g/cm}^3$  であった。

【0035】尚、以上の各実施例 (1~4) で用いられた SiC 粉末に関し、その粒径は1~3 [ $\mu\text{m}$ ] であり、諸特性は密度 ( $\rho$ ) が  $2.5 \text{ g/cm}^3$ 、熱膨張係数 ( $\alpha$ ) が  $3.1 \times 10^{-6}/^{\circ}\text{C}$ 、熱伝導率 ( $\kappa$ ) が  $280 \text{ W/m} \cdot \text{K}$  である。

【0036】各実施例 (1~4) からは、既知の粉末混合法による Cu-Mo 系複合材料 (TT-RCM) の作製に際して Cu の含有量を40wt%未満に規制した上、0.5~5 [wt%] の SiC 粉末を添加して高放熱性金属複合板材を得ると、軽量化及び低熱膨張化が具現され、高放熱性が向上する上、機械加工性も良好となることが判る。

【0037】ところで、以上の各実施例 (1~4) で得

られた各板材に対し、図1に示されるように、段付け加工により凸型段付けを施して4種の別個な凸型段付基板1を作製した後、これらの各凸型段付基板1上に半田3によりそれぞれシリコンチップ2を設けて4種の高放熱性金属基板を得た後、これらの各高放熱性金属基板をセラミックパッケージに組み込んだ状態で熱サイクルテストを行ったところ、何れの場合に関しても亀裂等の発生が無く、接合界面からの剥離も認められなかった。又、実際の組み立て状態における放熱性は従来のもものと比べて大幅に向上していることも判った。

【0038】

【発明の効果】以上に述べた通り、本発明によれば、既知の粉末混合法による Cu-Mo 系複合材料 (TT-RCM) の作製に際して Cu の含有量を40wt%未満に規制した上、0.5~5 [wt%] の SiC 粉末を添加することにより、低熱膨張率で放熱性が高く、しかも軽量で機械加工性の優れた高放熱性金属複合板材が得られるようになる。又、この高放熱性金属複合板材を基板材料として用いて段付けを施して基板を作製し、その基板の上にシリコン半導体素子を設ければ、特にセラミックパッケージへの組み込みが好適で有効な高放熱性金属基板が得られるようになる。

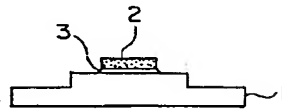
【図面の簡単な説明】

【図1】本発明の高放熱性金属複合板材を用いて構成される一実施例に係る高放熱性金属基板の基本構成を示した側面図である。

【符号の説明】

- 1 凸型段付き基板
- 2 シリコンチップ
- 3 半田

【図1】





## PATENT ABSTRACTS OF JAPAN



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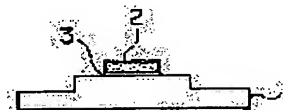
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 ICHIDA AKIRA

**(54) HIGH HEAT RADIATION METAL COMPOSITE SHEET AND HIGH HEAT RADIATION METAL SUBSTRATE USING THE SAME**

**(57)Abstract:**

**PROBLEM TO BE SOLVED:** To obtain a high heat radiation metal substrate by using a high heat radiation metal composite sheet having low coefficient of thermal expansion and high heat radiation characteristics, reduced in weight, and excellent in workability.

**SOLUTION:** A high heat radiation metal composite sheet, which is prepared by subjecting a powder mixture, consisting of, by weight, <40% copper (Cu), 0.5-5% silicon carbide (SiC), and the balance molybdenum (Mo), to compacting and to sintering and then rolling the resultant sintered compact and further has characteristics of  $6.0-8.5[\times 10^{-6}/^{\circ}\text{C}]$  average thermal expansion coefficient,  $\leq 10\text{g/cm}^3$  density, and  $\geq 200\text{W/m.K}$  thermal conductivity, is used as a substrate material. Projection stepping is applied to this sheet to form a protrudedly stepped substrate 1. Then, a silicon chip 2 is provided onto the protrudedly stepped substrate 1 by means of a solder 3, by which the high heat radiation metal substrate can be obtained.



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**CLAIMS**

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**[Claim(s)]**

[Claim 1] The high heat dissipation nature metal compound plate characterized by an average coefficient of thermal expansion being in the range of 6.0-8.5 [ $\times 10^{-6}/\text{degree C}$ ] while being produced by rolling out, after fabricating the mixed powder which mixes and changes and sintering the copper below 40wt% (Cu), and the silicon carbide (SiC) and remainder molybdenum (Mo) of 0.5-5 [wt%].

[Claim 2] It sets to a high heat dissipation nature metal compound plate according to claim 1, and consistencies are 10 g/cm<sup>3</sup>. High heat dissipation nature metal compound plate characterized by thermal conductivity having the property of 200 or more W/m-K while being the following.

[Claim 3] The high heat dissipation nature metal substrate characterized by preparing a silicon semiconductor device and changing on the substrate which performed and obtained joggling to the high heat dissipation nature metal compound plate according to claim 1 or 2.

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## DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the high heat dissipation nature metal substrate with which the inclusion to a ceramic package etc. used a suitable high heat dissipation nature metal compound plate and suitable it.

[0002]

[Description of the Prior Art] Conventionally, as for the electrode for support and the substrate for loading of a semiconductor device, the calorific value at the time of use is increasing with the densification of a chip, improvement in the speed of data transmission, etc. Such increase-ization of calorific value is the cause which causes malfunction of a semiconductor device, degradation, breakage, etc.

[0003] For this reason, as a property fundamental to a substrate ingredient, the heat dissipation effectiveness is high, and to use the lightweight thing which the coefficient of thermal expansion moreover approximated to the semiconductor device itself and its circumference ingredient is desired as it can do. Moreover, to use what the coefficient of thermal expansion approximates to the substrate ingredient to the ingredient of the package for incorporating the substrate in the condition of having carried this besides the semiconductor device itself may be wished, or to use that from which a coefficient of thermal expansion differs a little to the semiconductor device itself and its circumference ingredient in consideration of matching after assembly may be wished. Furthermore, the substrate ingredient is required to be easy to perform \*\* attachment and plating etc. as a preparation process for building a substrate into a package. In addition, it is required for the substrate that such joggling processing should also be easy not only for a plate but the thing of types with a stage, such as a concave and a convex type, into a substrate ingredient for a certain reason.

[0004] As a substrate ingredient (plate) of high heat dissipation nature which may fill such a demand, in recent years, Cu-Mo system composite material (TT-RCM) is developed, and it is already put in practical use.

[0005]

[Problem(s) to be Solved by the Invention] In the case of the Cu-Mo system composite material (TT-RCM) mentioned above, there is a problem that heat dissipation nature is high and moreover cannot fully fill with the demand to the latest substrate ingredient for semiconductor devices, i.e., a low-fever expansion coefficient, demand of being lightweight.

[0006] Cu-Mo some which were produced with powder alligation differing, speaking concretely, as shown in the following table 1 -- in the Cu-Mo system composite-material (TT-RCM) property of a mixing ratio, if coefficient of thermal expansion is low, it turns out that a demand into the latest substrate ingredient mentioned above also about which thing -- heat dissipation nature is inferior -- must have been filled.

[0007]

[Table 1]

表 1 TT-RCMの特性

銅 質 量 %	0 (Mo)	20	40	60	80	100 (Cu)
密 度 ( $g/cm^3$ )	10.2	9.9	9.8	9.4	9.2	8.9
熱膨張係数 ( $\times 10^{-6}/^{\circ}C$ )	5.1	7.5	8.7	12.3	15.9	17.0
熱伝導率 ( $W/m \cdot K$ )	142	170	234	286	338	394



[0008] This table 1 shows that the coefficient of thermal expansion is quite large, although the copper (Cu) content of thermal conductivity is high about the thing beyond 40wt%. for this reason, such Cu-Mo - when the thing of a mixing ratio is used as a substrate ingredient for ceramic package inclusion, there is risk of a crack etc. occurring for mismatching with a ceramic package.

[0009] On the other hand, although there is an advantage that matching nature with a ceramic package becomes good if a copper (Cu) content uses as a substrate ingredient for ceramic package inclusion according to a coefficient of thermal expansion being small about the thing below 40wt%, there is a danger of being hard coming to miss the heat generated with a chip, and on the other hand causing malfunction etc. by the heat conductivity being small, and dependability will be spoiled.

[0010] That is, in the case of the conventional Cu-Mo system composite material (TT-RCM), also when the demand to the latest substrate ingredient for semiconductor devices must have been filled and it uses as a substrate ingredient for the inclusion to a ceramic package, there is a problem of machinability being bad and being hard to apply it.

[0011] By the way, although the copper-tungsten (CMSH) is known for less than  $[8.5 \times 10^{-6} / \text{degree C}]$  for thermal conductivity as a substrate ingredient of 200 or more W/m-K, substrate ingredients other than Cu-Mo system composite material (TT-RCM), i.e., a coefficient of thermal expansion According to this copper-tungsten (CMSH) having a consistency as large as 15.6-17  $[\text{g/cm}^3]$ , and machinability when difficulty is in the embodiment of lightweight-izing being bad etc. As latest substrate ingredient for semiconductor devices, it is not suitable for practical use like the case of the Cu-Mo system composite material (TT-RCM) mentioned above.

[0012] Made that this invention should solve such a trouble, the technical technical problem has high heat dissipation nature, moreover is lightweight at a low-fee expansion coefficient, and is to offer the high heat dissipation nature metal substrate which used the high heat dissipation nature metal compound plate and it which were excellent in machinability.

[0013]

[Means for Solving the Problem] After fabricating the mixed powder which mixes and changes and sintering the copper below 40wt% (Cu), and the silicon carbide (SiC) and remainder molybdenum (Mo) of 0.5-5  $[\text{wt}\%]$ , while being produced by rolling out according to this invention, the high heat dissipation nature metal compound plate which has an average coefficient of thermal expansion in the range of 6.0-8.5  $[\times 10^{-6} / \text{degree C}]$  is obtained.

[0014] Moreover, according to this invention, it sets to the above-mentioned quantity heat dissipation nature metal compound plate, and consistencies are 10  $\text{g/cm}^3$ . While being the following, the high heat dissipation nature metal compound plate in which thermal conductivity has the property of 200 or more W/m-K is obtained.

[0015] furthermore -- according to this invention -- the above -- the high heat dissipation nature metal substrate which prepares a silicon semiconductor device and changes on the substrate which performed and obtained joggling to which high heat dissipation nature metal compound plate is obtained.

[0016]

[Embodiment of the Invention] An example is given to below and the high heat dissipation nature metal substrate which used the high heat dissipation nature metal compound plate of this invention and it is explained to a detail with reference to a drawing.

[0017] First, the outline of the high heat dissipation nature metal compound plate of this invention is explained briefly. After this high heat dissipation nature metal compound plate fabricates the mixed powder which mixes and changes and sinters the copper below 40wt% (Cu), and the silicon carbide (SiC) and remainder molybdenum (Mo) of 0.5-5  $[\text{wt}\%]$ , it is produced by rolling out. For many properties of this high heat dissipation nature metal compound plate, an average coefficient of thermal expansion is in the range of 6.0-8.5  $[\times 10^{-6} / \text{degree C}]$ , and consistencies are 10  $\text{g/cm}^3$ . While being the following, thermal conductivity is 200 or more W/m-K.

[0018] If joggling is performed to such a high heat dissipation nature metal compound plate by joggling processing, a substrate is accomplished and a silicon semiconductor device is prepared on the substrate, the inclusion to a ceramic package is constituted as a suitable high heat dissipation nature metal substrate.

[0019] Then, about the high heat dissipation nature metal compound plate from which an ingredient presentation ratio (presentation content) differs based on some examples, the following doubles the manufacture approach and explains it concretely.

[0020] In the <example 1> example 1, first, as raw material powder, molybdenum (Mo) powder, electrolytic copper (Cu) powder, and silicon carbide (SiC) powder were mixed at a rate of 70:30:3.1, and after carrying out press forming, it sintered in the hydrogen ambient atmosphere. Next, after carrying out

heating maintenance was sintered compact for 15 minutes at 900 degrees C in a hydrogen ambient atmosphere, and carrying out hot rolling processing, the plate with a thickness of 1.0mm was made by performing cold rolling processing.

[0021] then, the place which investigated many properties of this plate -- a coefficient of thermal expansion ( $\alpha$ ) --  $7.5 \times 10^{-6}/\text{degree C}$  and thermal conductivity ( $\kappa$ ) --  $220 \text{ W/m-K}$  and a consistency ( $\rho$ ) --  $9.7 \text{ g/cm}^3$  it was .

[0022] Moreover, after forming nickel (nickel) plating so that thickness may be set to 3 micrometers by electrolysis at this plate, when it heat-treated under the conditions for 850 degree-Cx 20 minutes and membrane formation workability was investigated in the hydrogen ambient atmosphere, it blisters about plating, there is no deterioration of discoloration, a stain, etc., and the defect was not accepted.

[0023] the place which investigated many properties about the plate which incidentally produced (Molybdenum Mo) powder:electrolytic copper (Cu) powder in the procedure same as 70:30, without including silicon carbide (SiC) as a comparison -- a coefficient of thermal expansion ( $\alpha$ ) --  $7.7 \times 10^{-6}/\text{degree C}$  and thermal conductivity ( $\kappa$ ) --  $190 \text{ W/m-K}$  and a consistency ( $\rho$ ) --  $9.7 \text{ g/cm}^3$  it was .

[0024] In the <example 2> example 2, as raw material powder, molybdenum (Mo) powder, electrolytic copper (Cu) powder, and silicon carbide (SiC) powder were mixed at a rate of 70:30:4.2, and the plate with a thickness of 1.0mm was produced through the same procedure as an example 1 after this.

[0025] then, the place which investigated many properties of this plate -- a coefficient of thermal expansion ( $\alpha$ ) --  $7.3 \times 10^{-6}/\text{degree C}$  and thermal conductivity ( $\kappa$ ) --  $230 \text{ W/m-K}$  and a consistency ( $\rho$ ) --  $9.7 \text{ g/cm}^3$  it was .

[0026] Moreover, after performing and heat-treating nickel plating like the case of an example 1 here, when \*\*\*\* (BAg-8) attachment was further performed to the silicon wafer, nickel plating and the adhesion workability of \*\*\*\* were good, and defects, such as a crack and exfoliation, were not accepted.

[0027] When the process to \*\* attachment was similarly performed about the plate which incidentally produced (Molybdenum Mo) powder:electrolytic copper (Cu) powder as 70:30, without including silicon carbide (SiC) as a comparison also here, the crack was accepted in the \*\* attachment section and it turned out that adhesion workability deteriorates.

[0028] In the <example 3> example 3, as raw material powder, molybdenum (Mo) powder, electrolytic copper (Cu) powder, and silicon carbide (SiC) powder were mixed at a rate of 80:20:4.2, and the plate with a thickness of 1mm was produced through the same procedure as an example 1.

[0029] then, the place which investigated many properties of this plate -- a coefficient of thermal expansion ( $\alpha$ ) --  $6.7 \times 10^{-6}/\text{degree C}$  and thermal conductivity ( $\kappa$ ) --  $210 \text{ W/m-K}$  and a consistency ( $\rho$ ) --  $9.8 \text{ g/cm}^3$  it was .

[0030] Moreover, it was good, when nickel plating and \*\*\*\* attachment were given like the case of an example 2 also here and adhesion workability was investigated.

[0031] the place which investigated many properties about the plate which incidentally produced (Molybdenum Mo) powder:electrolytic copper (Cu) powder in the procedure same as 80:20, without including silicon carbide (SiC) as a comparison also here -- a coefficient of thermal expansion ( $\alpha$ ) --  $6.9 \times 10^{-6}/\text{degree C}$  and thermal conductivity ( $\kappa$ ) --  $175 \text{ W/m-K}$  and a consistency ( $\rho$ ) --  $9.9 \text{ g/cm}^3$  it was .

[0032] In the <example 4> example 4, as raw material powder, molybdenum (Mo) powder, electrolytic copper (Cu) powder, and silicon carbide (SiC) powder were mixed at a rate of 90:10:5.3, and the plate with a thickness of 1mm was produced through the same procedure as an example 1.

[0033] Then, when many properties of this plate were investigated, the coefficient of thermal expansion ( $\alpha$ ) was [  $202 \text{ W/m-K}$  and the consistency ( $\rho$ ) of  $6.0 \times 10^{-6}/\text{degree C}$  and thermal conductivity ( $\kappa$ ) ]  $10.0 \text{ g/cm}^3$ .

[0034] the place which investigated many properties about the plate which incidentally produced (Molybdenum Mo) powder:electrolytic copper (Cu) powder in the procedure same as 90:10, without including silicon carbide (SiC) as a comparison also here -- a coefficient of thermal expansion ( $\alpha$ ) --  $6.2 \times 10^{-6}/\text{degree C}$  and thermal conductivity ( $\kappa$ ) --  $163 \text{ W/m-K}$  and a consistency ( $\rho$ ) --  $10.0 \text{ g/cm}^3$  it was .

[0035] In addition, the particle size is 1-3 [ $\mu\text{m}$ ] about the SiC powder used in each above example (1-4), and, for a consistency ( $\rho$ ),  $2.5 \text{ g/cm}^3$  and a coefficient of thermal expansion ( $\alpha$ ) are [  $3.1 \times 10^{-6}/\text{degree C}$  and the thermal conductivity ( $\kappa$ ) of many properties ]  $280 \text{ W/m-K}$ .

[0036] After regulating the content of Cu less than [ 40wt% ] from each example (1-4) on the occasion of production of the Cu-Mo system composite material (TT-RCM) by known powder alligation, If the SiC powder of 0.5-5 [wt%] is added and a high heat dissipation nature metal compound plate is obtained,

when lightweight-ization and low-thermal expansion-ization will be embodied and high heat dissipation nature will improve, it turns out that machinability also becomes good.

[0037] By the way, to each plate obtained in each above example (1-4), as shown in drawing 1 After performing convex type jogging by jogging processing and producing four sorts of separate substrates 1 with \*\*\*\*\*, After forming a silicon chip 2 with solder 3 on each of these substrates 1 with \*\*\*\*\*, respectively and obtaining four sorts of high heat dissipation nature metal substrates, Where each of these high heat dissipation nature metal substrates are built into a ceramic package, when the heat cycle test was performed, there is no generating of a crack etc. also about which case, and the exfoliation from a junction interface was not accepted, either. Moreover, the heat dissipation nature in an actual assembly condition was also understood that it is improving sharply compared with the conventional thing.

[0038]

[Effect of the Invention] After regulating the content of Cu less than [ 40wt% ] on the occasion of production of the Cu-Mo system composite material (TT-RCM) by known powder metallurgy according to this invention as stated above, by adding the SiC powder of 0.5-5 [wt%], heat dissipation nature is high, moreover it is lightweight at a low-thermal expansion coefficient, and the high heat dissipation nature metal compound plate which was excellent in machinability comes to be obtained. Moreover, if jogging is performed using this high heat dissipation nature metal compound plate as a substrate ingredient, a substrate is produced and a silicon semiconductor device is prepared on that substrate, a high heat dissipation nature metal substrate suitable [ especially the inclusion to a ceramic package ] and effective will come to be obtained.

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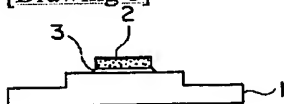
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DRAWINGS

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[Drawing 1]



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**CORRECTION OR AMENDMENT**


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[Kind of official gazette] Printing of amendment by the convention of 2 of Article 17 of Patent Law  
 [Section partition] The 4th partition of the 3rd section  
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 H01L 23/36 M

[Procedure revision]  
 [Filing Date] July 24, Heisei 12 (2000. 7.24)  
 [Procedure amendment 1]  
 [Document to be Amended] Specification  
 [Item(s) to be Amended] 0027  
 [Method of Amendment] Modification  
 [Proposed Amendment]  
 [0027] When the process to \*\* attachment was similarly performed about the plate which incidentally produced (Molybdenum Mo) powder:electrolytic copper (Cu) powder as 70:30, without including silicon carbide (SiC) as a comparison also here, the crack was accepted in the \*\* attachment section and it turned out that adhesion workability is inferior.

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[Translation done.]